The Impact of River Basin Size on the Distribution and Character of Preserved Strata: A Comparison of the Po and Apennine Systems

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LONG-TERM GOALS

The ultimate objective of this research program is to obtain a predictive understanding of the physical and biological processes responsible for the formation, alteration and preservation of sedimentary signals on continental margins. The general approach is the development and testing of theory mainly through field observations and measurements.

OBJECTIVES

The scientific goals of this project are twofold. First, we are testing the idea that river basin size has a first-order impact on the initial distribution and character of strata in the receiving basin. In particular, we hypothesize that large rivers (e.g. Po), in which discharge peaks are decoupled from oceanic conditions, produce thick beds that have large horizontal continuity and significant vertical (i.e., temporal) variation in physical properties. In contrast, small rivers (e.g., Apennine rivers) produce thin beds, which due to subsequent bioturbation have low horizontal continuity and little vertical variability. Second, we are exploring the idea that large scale spatial variability in critical shear stress – due to variability in the detrital carbonate content of the seabed – may control accumulation rate patterns in the western Adriatic.

APPROACH

Our approach is to use a combination of focused event-response and broad-area survey coring to measure the distribution, internal characteristics (e.g., sedimentary structure, porosity) and dynamical properties (e.g., mineralogy, grain size) of near-surface strata. A state-of-the-art digital x-radiography system provides real time information on sediment fabric and guides subsequent coring and subsampling strategies. In addition, profiles of resistivity are measured shipboard and samples collected for analysis of short-lived radionuclides. In the laboratory, we use various image-processing techniques to analyze x-radiographs, as well as γ spectroscopy to enumerate radionuclides.

WORK COMPLETED

Two cruises were conducted during the past year. The first was a 4-day cruise in October 2001 on the MV Sarom VIII, during which we collected a large number (~ 75) of box cores on the Po River margin. The second was a 3-week cruise on the RV Urania in April 2002 during which a subset of the stations on the Po margin were reoccupied and additional survey coring (box and Kasten) was conducted on the Apennine margin. In addition to the field activities, the extensive set of digital x-

radiographs and resistivity profiles collected since December 2000 have undergone preliminary processing and analysis and γ counts of short-lived radionuclides (^{7}Be, ^{234}Th) in samples from the October and April cruises have been completed.

RESULTS

To date our results obtain solely from the Po River flood deposit research. There, we have used two independent image segmentation algorithms (brightness thresholding & edge detection) to objectively measure the thickness of the October 2000 Po River flood deposit. The resulting isopach map indicates the flood deposit is located immediately offshore the major distributaries of the river in water depths of 10 to 25 m. Maximal thickness if off the main mouth (Pila), where > 35 cm of sediment was deposited, but secondary depocenters are located off the mouths of the Tolle and Gnocca/Goro. The sharp thickness gradients are consistent with the idea that the Po flood sediment was delivered into a quiescent receiving basin.

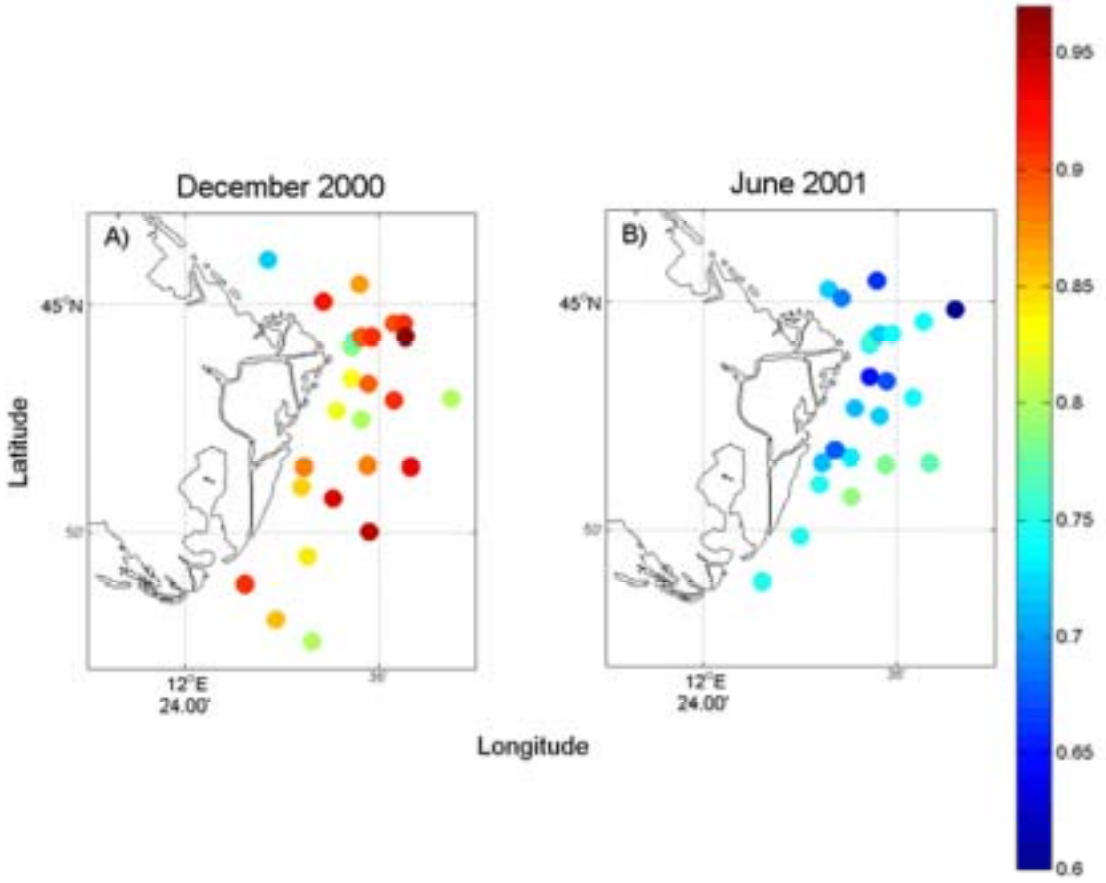

Figure 1. Maps of Po River margin showing the change in near-surface porosity from December 2000 (mainly > 0.80) to June 2001 (mainly < 0.80).

Post-depositional alterations to the Po flood deposit include consolidation, additional deposition and bioturbation. The former is particularly important because it indicates significant strengthening of the seabed (Figure 1). Moreover, by taking into account consolidation, the available time-series data indicates no net erosion of the flood deposit, but considerable deposition near the Pila mouth.

IMPACT/APPLICATIONS

Oceanic flood deposition is a globally significant process that has a first order impact on seabed character (e.g., impacts presence/absence of bedding, erodibility). Therefore, obtaining a better understanding of oceanic flood deposition will have broad relevance to acoustical and optical applications of the Fleet.

TRANSITIONS

The development of a shipboard digital x-radiography system is an enabling technology that has had widespread application. First, we have used the x-radiographs to guide coring in near real time. In addition, sampling for radionuclides (e.g., Nittrouer) and grain size (e.g., Hill & Milligan) are facilitated using the imagery.

RELATED PROJECTS

Our research is closely related to that of three other groups. First, we are collaborating with Chuck Nittrouer and Andrea Ogston (University of Washington) in documenting the initial distribution and post-depositional alteration of the October 2000 Po River flood deposit. Second, we are working with Paul Hill (Dalhousie University) and Tim Milligan (Bedford Institute of Oceanography) in determining the bed-scale property variations, especially grain size, of the Po flood deposit as imaged using the digital x-radiography system. Third, we will be working with Patricia Wiberg (University of Virginia) during CY03 on studies of spatial variability in critical shear stress in the western Adriatic.